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LEVERAGING TECHNOLOGY TO REDUCE
THE INCIDENCE OF FRATRICIDE

BY

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LEVERAGING TECHNOLOGY TO REDUCE THE INCIDENCE OF FRATRICIDE

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INTRODUCTION

"In a deadly military blunder, American
fighter planes shot down two United
States Army helicopters today as they
were carrying a team of officials from
four allied nations over the Kurdish en-
clave in northern Iraq.

The shootdown, which killed all 26
people on board the two craft, occurred
after two F-16C jets enforcing the no-
flight zone over northern Iraq mistook
the aircraft for Iraqi helicopters after
flying near them to identify them
visually."[1]

As a result of that horrible tragedy, once again, the
topic of fratricide or friendly fire teemed the headlines.
The shootdown served as yet another reminder of the
lethality of our war-fighting systems. More importantly, it
focused attention on the potential frailty of humans in
dealing with high technology and split second decisions.

This paper will define fratricide and trace it's
occurrence since the 18th century. It will document that
fratricide is not a recent phenomena, rather an evolution of
the problem of positive combat identification. It will
analyze the application of technology in our modern war-
fighting systems, evaluating the potential adverse impacts
of applying mismatched, non-integrated or incomplete
technology to a requirement. The paper will substantiate
the criticality of thorough requirements analysis prior to
implementation of technology in major weapons system. The

paper will show that the high fratricide rates in the Gulf War were due to incomplete and non-integrated applications of technology, resulting in a 'blind' spot for the lethal warfighting systems. The paper will discuss fixes made during the Gulf War and current initiatives to solve the problem. Finally, it will offer recommendations to minimize the incidence of fratricide in future conflicts.

As a society, we are enamored with technology and the capabilities which can be achieved through it's use. This is not bad. However, given the lethality of our war-fighting systems, it is imperative that the application of technology be carefully analyzed and that the consequences of inappropriate or incomplete application be averted. In a recent editorial , COL (Ret) Harry Summers admonished Walter Lippmann for writing in December 1941 that air and sea power would prevail in World War II, with ground forces playing a minor role. Summers rebutted that argument.

> "Lippmann does not understand the dynamics of the Army where man is still dominant and the machine merely a tool. Technology must serve the soldier, not vice versa."[2]

Summers is right. Requirements should drive the technology, not vice versa. We should apply technology where it is appropriate and not use it if the effects will severely imperil America's fighting force. We must

critically evaluate the importance of the man-machine interface to minimize the possibility of fratricide.

Digitization of the battlefield, an ongoing initiative of the current Army Chief of Staff, must ensure that information available to commanders at all levels is consonant with the tactical environment. We must apply vigorously those capabilities that have minimal adverse impacts on the fighting force. Conversely, we must carefully and fully investigate those capabilities that could ultimately result in the deaths of United States' Service personnel through fratricide. We should apply technology based on a judicious evaluation of what technologies best apply to which systems. General Gordon R. Sullivan, Army Chief of Staff, recognizes that technology alone will never be the last word on the battlefield. "War is a human endeavor. Technology alone is not the answer; it never is."[3]

The Gulf War verified the importance of superior knowledge on the battlefield. It was the first high technology information warfare. This control of knowledge, and its denial to the enemy, proved to be an indispensable factor. As Alan Campen noted in the Introduction to The First Information War, we could see, hear and talk all through the war. After a few hours, the enemy could not. The use of technology to leverage battlefield information will be a most valuable asset in future wars. Campen, in the preface of his book, discussed the principles of

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information warfare technology and it's ability to support a leaner and cheaper force, while still maintaining the capability to effectively support the nation's goals and objectives. Operation Desert Storm was the first high technology information war. Victory in any future conflicts will hinge on our ability to leverage information...to win the information war. A vital part of the information war is the prevention and minimization of fratricide.

FRATRICIDE DEFINED

The official definition of fratricide is important in understanding the relative lack of serious attention to this problem prior to the Gulf War. The Center for Army Lessons Learned, quoting from the U.S. Army Training and Doctrine Command's Fratricide Action Plan, defines fratricide as:

> "The employment of friendly weapons and munitions with the intent to kill the enemy or destroy his equipment or facilities, which results in unforeseen and unintentional death or injury to friendly personnel."[4]

In a recently published study on fratricide, Army Colonel Kenneth Steinweg argued that, "This restrictive definition precludes accidental weapon explosions and misfires, training accidents, casualties from unexploded ordnance or unintentional self wounding of any kind. This artificially reduces the true fratricide percentage rate."[5] It reflects the Army's previous propensity to minimize the

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percentage of fratricide incidents, effectively ignoring the problem.

In his 1982 paper on the same subject, LTC Charles Shrader coined the term "amicicide". He derived the legitimate combination of the Latin noun amicus, -us (friend) with the common latinate suffix for killing (-cide). Shrader thought that the terms friendly fire and fratricide were clumsy and subject to interpretation. He believed amicicide provided a single word that better described the incidence of human casualties.[6] Fratricide, at that time applied, most often, to casualties inflicted by artillery projectiles. The limited definition artificially lowered 'true' fratricide rates.

HISTORY OF FRATRICIDE IN WAR

A brief history of fratricide since the 18th century illustrates the evolution of problems in positive combat identification. The history documents that combat identification remains a critical problem, particularly with our technological capability to engage targets at previously unfathomable ranges. These ranges go beyond the capability to visually distinguish friend from foe.

In 1758, during the French and Indian War, the commander of a British detachment and Colonel George Washington, a colonial officer of the British Army, mistakenly identified each others' forces as French. In his papers, Washington reported that between 13 and 40 British soldiers died at the hands of their own forces during the

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ensuing engagement.[7] Uniforms, at that time, identified

alliance. Due to the 'fog of war', that identification

means proved to be ineffective.

Fratricide knows no rank. A sentry mortally wounded

Lieutenant General Thomas J. "Stonewall" Jackson as he

returned to Southern lines from a reconnaissance mission at

Chancellorsville. In 1863, a year before Jackson's death,

the Confederates alone recorded no less than four incidents

of friendly fire resulting in numerous casualties at the

Battle of Shiloh. Numerous other documented occurrences of

fratricide throughout the Civil War substantiate the

continuing problem of combat identification.

Fratricide knows no nationality. Of the five

million French casualties in World War I, artillery caused

two thirds, regardless of friend or foe. French General

Alexandre Percin believed that French artillery fire caused

one million, or 20% of French casualties. He adjusted that

figure, though, to seventy-five thousand, or 2.2%, based on

a survey of rear-area hospitals by another general. He

thought it would prove more acceptable to fellow officers

discussing responsibility for excessive casualties.[8]

Unfortunately, the incidence of fratricide did not

decline during World War II. During the breakout from

Normandy, British aircraft inadvertently bombed the 30th

Division for over two days. Lieutenant General Leslie J.

McNair died from injuries in that bombing. Incidents

occurred throughout the war. At the Battle of the Bulge,

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the First Infantry Division became the target of heavy 'friendly' bombing. In St. Lo, France over 750 casualties occurred as a result of U.S. bombers attacking American ground forces. John Roos, in an article in the Armed Forces Journal, reported on a unique fratricide occurrence. In a bizarre air to air fratricide incident in 1944, a B-17 strayed beneath another bomber and had its tail hit and destroyed by a falling bomb.[9] Combat identification continued as a significant problem.

In the Pacific theater of World War II, an allied destroyer depth charged and sank an allied submarine. Likewise, in the Caribbean, friendly fire sank an American submarine, the USS Dorado. During the Burma Campaign at Ritpong, Chinese troops suffered thirty killed and one hundred wounded. Based on observation of injuries, a U.S. Army surgeon, documented that more than 80% of the casualties appeared as a result of Chinese fire.[10]

The Korean War saw similar occurrences of fratricide. In one horrific incident, a napalm bomb dropped by an American plane incinerated nearly an entire U.S. Marine platoon. PFC James Ransome Jr., a survivor, described the situation in an interview in Clay Blair's The Forgotten War. "Men I knew, marched and fought with begged me to shoot them....I couldn't. It was terrible."[11]

Combat identification problems continued in Vietnam. Perhaps one of the most noteworthy artillery friendly fire incidents occurred in the infantry battalion of LTC H.

Norman Schwartzkopf. C. D. B. Bryan chronicled the after effects in his book Friendly Fire, a riveting account of the grief, sorrow, bitterness and outrage of the victim's parents.

In his study, Shrader referenced many Vietnam friendly fire occurrences. Among them was a similarly terrible artillery incident. It happened in 1967 when a gun crew cut an incorrect powder charge. They applied a Charge 7 rather than the fire direction center's Charge 4 computation. The "long" round killed one and wounded thirty-seven U.S. soldiers. Grievously, the victim's unit initiated extremely accurate counterbattery fire resulting in an additional fifty-three casualties. The entire incident occurred in the short span of twenty-three minutes.[12]

In a recent keynote address on fratricide, the Assistant Secretary of Defense for Command, Control, Communications and Intelligence reported that fratricide caused over 30% of all aircraft losses during the 1973 Israeli-Egyptian War. The 1982 Israeli-Syria conflict resulted in further exacerbation of the problem. The Israeli's experienced great difficulty in discriminating highly effective Syrian helicopters from their own.[13] Even with the advancement of high technology aircraft, combat identification accounted for continued fratricide incidents.

Incidents of fratricide also occurred in Grenada and Panama. In Grenada, four Navy A-7 aircraft strafed an U.S. Army command post, inflicting seventeen American casualties.

Similarly, in Panama, friendly fire incidents, depending upon the calculation method used, resulted in a fratricide rate estimated at between 6 and 12%. In Operation Just Cause, fratricide accounted for three of twenty-three killed and between sixteen and thirty seven of three hundred ten wounded, as reported by Secretary of Defense spokesman Pete Williams during the June 19, 1990 daily briefing.[14] Because of lax record keeping and the various definitions of what constitutes fratricide, there can be a considerable difference in the reported fratricide rate.

As this brief history documents, fratricide is not a new phenomena, rather a recurring and deadly problem in combat identification. Despite the evolution of high technology systems for warfighting, 'blind' spots exist and fratricide continues to occur.

OPERATION DESERT STORM: THE FIRST HIGH TECHNOLOGY WAR

The Gulf War culminates this historic review. Ground combat identification again emerged as the core issue related to fratricide. In an article published in the Journal of Electronic Defense, Vito DeMonte succinctly described the friendly fire statistics of Operation Desert Storm.

> "Never before have we fought such a short war, in such a confusing environment, with such a great percentage of deaths due to friendly fire."[15]

Friendly fire killed thirty-five Americans and wounded seventy-two during the Gulf War. In a special column in The Washington Post, Robert MacKay reported that of the thirty-five Americans who died, twenty-four died as a result of ground-to-ground fire, and eleven succumbed to fire from U.S. aircraft.[16] The Office of Technology Assessment (OTA) determined that the official friendly fire casualty rate for Desert Storm was 24%.[17] This figure did not include the British soldiers killed by aircraft bombing, nor did it include engineer and medical personnel, casualties of unexploded ordnance. As documented in his paper on unexploded ordnance, LTC Gary Wright stated that ninety-four separate incidents involving unexploded ordnance occurred during Operation Desert Storm. These incidents equated to one hundred and four woundings and thirty deaths, 10% of total casualties in the operation.[18] Rick Atkinson of The Washington Post reported that despite the hundreds of fixed and rotary winged aircraft from more than a dozen allied nations, none of the Gulf War fratricide cases involved air-to-air fratricide.[19]

UNDERSTATEMENT OF FRATRICIDE RATES

The high incidence of fratricide in the Gulf War brought new and heightened attention to this historically troubling problem. The Office of Technology Assessment agreed [with Steinweg] that past rates of fratricide were systematically and substantially underestimated.[20] LTC Shrader's 1982 study, though "primarily historical,

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narrative, and highly selective", concluded that "casualties attributable to friendly fire in modern war constitute a statistically insignificant portion of total casualties (perhaps less than 2 percent)."[21] Because of the dearth of published documents on this subject, Shrader's assessment had become the de facto standard. In subsequent published articles, Shrader acknowledged that actual fratricide rates are considerably higher than two percent.[22] In a 1993 interview, Shrader further acknowledged that higher rates are prevalent. He stated that, "It just seemed to be the number that I kept coming up with, based on the materials that I had to work with, which were pretty limited."[23]

In a 1994 paper on the subject, medical doctor and Army Colonel Kenneth K. Steinweg substantiated his thesis that fratricide rates during conflicts of the Twentieth Century equaled at least five to eight times the number than the generally accepted two percent figure.[24] Steinweg's study examined historical evidence of the Twentieth Century, experiences at the National Training Centers and the application of technology. Because the casualty reporting system failed (and continues to fail) to accurately document fratricide, Steinweg also used medical documents in substantiating his thesis. Steinweg concluded that, "Fratricide rates have been and are conservatively 10-15 percent of our casualties, not two percent."[25]

In 1992 another Army doctor, Colonel David M. Sa'adah, presented a paper to the 31st U.S. Army Operations Research

Symposium at Fort Lee, Virginia. Sa'adah compared data from five casualty surveys (three in the Pacific during World War II and two from the Vietnam War) with Desert Storm data. He concluded that all weapons available on the battlefield are potential contributors to friendly fire incidents. Further, he asserted that movement from defensive to offensive operations resulted in increased fratricide rates, sometimes by a factor of two.[26]

Operation Desert Storm was the first major conflict in which America's fighting forces used the high technology weapons systems designed and built during the Reagan Administration. It proved to be a major test of the billions of dollars invested. The One Hundred Hour War did liberate Kuwait and severely defeated Saddam Hussein's forces.

In an article published shortly after the Gulf War, John D. Morrocco, a writer for Aviation Week & Space Technology lauded the performance of the high technology systems used during the conflict. He also postulated that the Department of Defense would continue to press for high-leverage advanced technology systems.

> "Operation Desert Storm [has] validated the U.S. military's emphasis on quality versus quantity in weapon systems and provided a tremendous boost to the credibility of high-technology programs now in development."[27]

Yet, the fratricide rate rivaled that of all conflicts in this century.

In previous conflicts, artillery inflicted the highest percentage of fratricide deaths. The Office of Technology Assessment reported that the sole artillery fratricide incident in Desert Storm occurred on February 26, 1991 when one soldier died from injuries inflicted by the premature burst of an artillery round.[28] That single incident accounted for less than two percent of the fratricide casualties in the conflict. Steinweg and Sa'adah's research substantiates previous fratricide figures as routinely in the fifteen to twenty percent range, vice the previously quoted Shrader rate of 2%.

Desert Storm data revealed a new paradigm. At the 1994 Combat Identification System Conference, Colonel Sa'adah reported that the M1A1 Abrams tank inflicted seventy one percent of fratricide casualties during the war.[29] _Journal of Electronic Defense_ writer Zachary Lum further substantiated Sa'adah's findings.

> "The Abrams M1A1 was the worst offender in the Gulf, responsible for 85% of the fratricide casualties. (The U.S. lost 10 tanks in the war, seven to fratricide; of 28 Bradley Fighting Vehicles destroyed, 22-23 were victims of fratricide.)"[30]

Sa'adah's research documented the redundant lethality of what he termed weapon 'platforms'.

> "The fratricide agent is not the
> specific weapon, but the platform where
> the firing decision resides...The main
> gun is accurate and lethal to the target
> vehicle, but it was the follow-on with
> the lesser armament that created the
> majority of casualties."[31]

The variation in calculated fratricide rates highlights
the difficulty in definition (Shrader and Steinweg), as well
as the non-standard application of calculation
methodologies. Nevertheless, figures clearly substantiate
the significance of the problem and fall in line with
Steinweg and Sa'adah's findings.

As a result of the Desert Storm figures, fratricide
became a topic of increased attention. The Department of
Defense (DoD) and the services formed Fratricide Task
Forces. The Army Materiel Command formed the Army's
Fratricide Task Force.   In an August 1993 article in the
<u>Journal of Electronic Defense</u>, Colonel David O. Bird, Team
Chief of the Army Material Command's (AMC) Fratricide Task
Force, spoke of the high priority in coming to the quickest
possible total solution for fratricide reduction. "Reducing
fratricide is 'right near the top, if not right at the top'
of the list of critical areas that the Army is currently
exploring."[32] Retired Navy Commander George Cornelius
reported in a <u>Signal</u> magazine article that the Gulf War
experience, because of air supremacy, rendered air-to-air
and ground-to-air identification problems nearly irrelevant.
However, the problem of air-to-ground and ground-to-ground

encounters revealed serious shortcomings in combat identification capabilities.[33]

The Department of Defense and Clinton Administration recognize that the probability of fratricide cannot be eliminated. Their reasonable goal is the reduction of fratricide. Secretary of Defense William Perry charged the services to rapidly develop and field, as a high priority, an integrated, enhanced identification capability to reduce the risk of fratricide to armor, aircraft and ships. He further declared that the Army should reduce the possibility of fratricide through enhancement of situational awareness technology.[34] Situational awareness is officially defined by the U.S. Army Combined Arms Command as:

> "The real-time accurate knowledge of one's own location [and orientation], as well as the locations of friendly, enemy, neutrals, and noncombatants. This includes awareness of the METT-T conditions that impact the operation."[35]

Similarly, Major General Wesley K. Clark, then a Deputy Chief of Staff at the U.S. Army Training and Doctrine Command, was quoted, "So we've got to focus on the minimization...recognize that we will never be able to prevent all instances of fratricide."[36]

The Office of Technology Assessment also recognized that reduction of fratricide is a correct and reasonable approach.

> "Reducing fratricide is desirable and
> feasible, but eliminating it is not.
> Although programs to reduce fratricide
> are certainly needed, setting a goal of
> eliminating it is unrealistic and
> probably counterproductive."[37]

Believing that the application of technology alone will solve the problem, is fallacious and foolhardy. As U.S. Navy Commander (Retired) George Cornelius stated in an article published by the U.S. Naval Institute Proceedings, "Electrons, however marvelous, can never relieve humans of the awful responsibility of the final, lethal decision to fire."[38]

Advances in technology, ironically enough, can exacerbate, rather than improve some situations. They are but one piece of the pie. Emmett Paige Jr., Assistant Secretary of Defense for Command, Control, Communications and Intelligence, recently substantiated this point in a keynote address to the 1994 U.S. DoD Joint Service Combat Identification Systems Conference.

> "Unless we have reliable means of
> positively identifying foes at long
> range, the technological advantage we
> have achieved in our weapon systems, at
> great expense, will be partly
> negated."[39]

Beyond Visual Range (BVR) technology permits detection of potential targets at previously unattainable ranges. As the term implies, the eye cannot detect, let alone identify a target as either friend or foe. BVR technology can detect

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targets significantly smaller than a pixel on our sensors, thereby precluding positive identification. Unfortunately, the Desert Storm record of fratricide proved a downside to these technological advancements. DeMonte highlights the major reason. "Engagement ranges became so extended that differentiation between friend or enemy leapt beyond the capability of the 'sensor-aided eyeball'."[40]

TIERED RAMIFICATIONS

The effects of fratricide can also severely impact unit cohesiveness and fighting ability. This is a secondary effect. The Center for Army Lessons Learned lists a number of degrading factors caused by fratricide. These factors include: loss of confidence in a unit's leadership; a sharp increase in self-doubt on the part of leaders; hesitation to use supporting combat systems (danger close artillery); oversupervision of units; loss of aggressiveness during fire and maneuver; needless loss of combat power; loss of initiative; disrupted combat operations; and finally, a general disruption of cohesion and morale.[41] Effectively, fratricide can 'kill' the fighting initiative of a unit.

Senior officers, briefing the press on Gulf War fratricide casualties, acknowledged the severe emotional effects of friendly fire.

> "Few traumas of war, exceed the anguish and shame of troops who learn they have taken allies under fire, and the effects on the receiving end are even worse."[42]

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Abigail Trafford, staff writer for The Washington Post, addressed the impacts on those who commit fratricide.

> "Those who commit friendly fire in military or civilian life face a long personal quest for self-forgiveness. Society is sympathetic and doesn't blame them. But it's not easy for the individual to overcome the crushing guilt."[43]

LTC Ralph Hayles, an Apache battalion commander who killed two and wounded four in a Desert Storm fratricide incident, is "still haunted by the memory of the two young men he killed."[44] In a Washington Post article chronicling one of the Gulf War fratricide incidents, Barton Gellman reported on the emotional impact. Following the destruction of engineer vehicles by an armored unit, "Bafflement, sorrow, shame and rage swept over the scene of the firefight as the cavalrymen realized what they had done."[45] The Troop Commander still dreams about the tragedy. "For the rest of my life, for the rest of all our lives, we'll be thinking, is there something we could have done?"[46] The importance of secondary psychological impacts of fratricide must not be ignored.

The impact of fratricide is further exacerbated by the improper reporting of incidents. Arthur T. Hadley, a New York Times reporter, believes that the press harshens the problem of under-reporting fratricide.

> "The press shares responsibility for the current furor because in the past it under-reported or failed to report

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casualties from friendly fire. This
left the public and, to some extent, the
military unfocused on the problem."[47]

Army Corporal Douglas "Lance" Fielder died in a
friendly fire incident during the Gulf War. Twenty eight
hours after his death, an Army casualty team reported to
Fielder's parents that their son died from injuries
inflicted by Iraq's Republican Guard. Two months later,
when Fielder's friends reached telephones in Saudi Arabia,
his parents learned the truth. Fielder's military escort
later reported that he was ordered to tell the dead man's
parents that their son was killed by Iraqis. Not until
August, nearly six months after Fielder's death, did the
Army give them official notice otherwise.[48] Such
unfortunate incidents inflict a double wound on the next of
kin. Effectively, there is a greater and more severe impact
than death by enemy fire. Because it should be preventable,
there is a perception of incompetence and a lack of
compassion. Fielder's mother best stated the impact.
"After the government lies to you, you don't trust
anything."[49]

Arthur T. Hadley, a New York Times reporter who
personally came under friendly fire in World War II and in
Vietnam, addressed the emotional impact on the relatives and
friends of friendly fire casualties.

> "One can understand such accidental
> deaths, while not always excusing them.
> But the families and friends of those
> who were or will be friendly fire

casualties should know in their grief
that all casualties are equal parts of
war."[50]

David Hackworth, a retired Army Colonel and syndicated
columnist, reported in a _Newsweek_ article on the impacts of
not being forthcoming in reporting fratricide incidents.

> "Many soldiers who served in the gulf
> feel that the lack of candor about
> fratricide and the delays in informing
> families smacked of a cover-up. Others
> blame the slow bureaucratic process of
> an organization that takes a while to
> admit mistakes in hopes that in the
> meantime, the public will lose
> interest."[51]

Major Charles F. Hawkins, U.S. Army Reserve, stressed
the importance of public support in times of crisis in an
article on friendly fire published by the U.S. Naval
Institute Proceedings.

> "The fact of fratricide can exact
> powerful political leverage against the
> use of force, particularly with a public
> now conditioned by media reports that
> friendly fire is typically a low figure.
> The President and Congress, relying on
> public support in times of crisis,
> should have the best data available to
> show that fratricide rates typically
> approach 20% or greater, and that
> available means are being used to reduce
> this tragic consequence of combat."[52]

NON-INTEGRATED APPLICATION OF TECHNOLOGY

To a large degree, the fratricide experienced during
the Gulf War was a legacy of previous weapons acquisition
policies. Planners and designers of high technology
warfighting systems, such as the Bradley Fighting Vehicle,

the Abram's tank, the Multiple Launched Rocket System
(MLRS), improved conventional munitions, and scatterable
mines failed to account for collateral or unforeseen
impacts. Employment of BVR technology without evaluating
all consequences, resulted in a 'blind' spot in the positive
identification of ground combat vehicles.

A review of official documents reveals recognition of
the need to improve combat identification. However, prior
to the Desert Storm experience with fratricide, little
substantive progress occurred in reducing it's incidence.
The Commander of the Combat Developments Command, in a
November 1967 letter to the Army Chief of Staff[53], observed
that soldiers must be conditioned to distinguish between
friend and foe. He recommended a study to analyze
modification of training firing ranges to condition trainees
to make a distinction of target prior to firing.

The November 1967 letter also highlighted another
observation in the category of U.S. casualties from own
fire. The letter reported that improvements in techniques
for visual recognition of friendly personnel and procedures
for battlefield identification appeared necessary.

Review of applicable Cost and Operational Effectiveness
Analyses (COEA) for combat vehicles in the late 1970's (the
systems later used in Desert Storm) revealed that combat
identification was not a system requirement. In the area of
survivability, COEA data consistently concentrated on the
areas of large and small caliber direct fire weapons;

indirect fire; mines; nuclear, biological and chemical weapons; and air attack.[54] In no single COEA was there a reference to combat identification or identification friend or foe technology.[55] Built in features such as fire suppression, blow out panels, hardened armor and protective linings served to increase survivability. These measures proved effective in minimizing the impacts of friendly fire during the Gulf War. As it turned out, the incorporation of identification friend or foe would have been a more effective survivability factor.

In a February 1974 letter following the 1973 Arab-Israeli conflict and the Israeli's difficulty in identifying friendly from enemy tanks, the Assistant Secretary of the Army for Research and Development acknowledged that there was not a battlefield IFF system for use with tanks.[56] He directed the Army staff and the U.S. Army Training and Doctrine Command to determine the Army's need for a battlefield IFF system for tanks.

In June 1982, J.R. Sculley, the Assistant Secretary of the Army for Research, Development and Acquisition, in a memorandum for the Under Secretary of Defense (Research and Engineering), concluded that there was no requirement for an electronic question and answer system for ground combat vehicles[57]. The Assistant Secretary based his recommendation on the results of a Battlefield Identification Friend-or-Foe (BIFF) Study.[58]

The Rand Corporation conducted a study on ground-to-ground fratricide at the National Training Center in 1986. In the study entitled, Applying the National Training Center Experience - Incidence of Ground-to-Ground Fratricide, Martin Goldsmith provided several conclusions. His data revealed that half of the recorded fratricides were preventable if the shooter had proper knowledge of the location of friendly units. Further, he found that one third of the fratricides were preventable with shooting tankers having knowledge of the location of individual friendly vehicles. Finally, Goldsmith found that seventeen percent of fratricides were also preventable with the implementation of IFF devices on combat vehicles.

In the case of the MLRS, a blind spot in doctrine emerged during the Gulf War. In his paper on the problem of unexploded ordnance (UXO) on the battlefield, LTC Gary Wright calculated that more than 1.5 million unexploded munitions remain on the Gulf War battlefield. Wright further documented that vast amounts of submunitions targeted beyond the Forward Support Coordination Line (FSCL) caused maneuver problems as ground forces thundered into Iraq. Wright documented that, "Many units found themselves in areas that were saturated with submunitions."[59] Further, Wright stated that, "The transfer or sharing of UXO information is not currently in our Joint or Service doctrine."[60]

Unfortunately, this is not a new phenomena. It applies, as well, to minefield placement. In the November 1967 letter previously cited, the Commander of the U.S. Army Combat Developments Command reported on the inadequate reporting and recording of friendly protective minefields. The commander reported that casualties in Vietnam occurred because units failed to record and/or retrieve minefields before moving. The report recommended renewed compliance with the published doctrine.

Project office technical management engineers and the Studies Branch Chief in the System Manager's Office for MLRS confirmed that:

> "The battlefield safety of operating areas where submunitions had been delivered was not considered during the design and early production of the system (MLRS). They (System's Manager's Office, Training and Doctrine Command) said the Army believed the weapon would most likely be used against the Soviet threat in Europe, where U.S. Troops would probably be in a defensive position. Therefore, U.S. soldiers were not expected to occupy submunitions-contaminated areas."[61]

The U.S. Army Training and Doctrine Command's System Manager for Cannon acknowledged that the "failure to consider effects of unexploded submunitions increased the potential for friendly deaths."[62]

Tank developers, likewise, failed to recognize the consequences of a non-integrated application of technology, i.e., identification friend or foe (IFF) technology for

ground combat vehicles. A senior Army officer who served over 29 years as a tank expert, reported in an interview that the issue of tanks' vulnerability to fratricide was not a significant part of building a better tank. Further, he indicated that such technologies as transponder systems were excluded from tank designs for a number of reasons.[63] Cornelius' research indicates that Army planners routinely dismissed IFF technology. Arguments for rejection included maintenance complexity, better use of room used otherwise, and perceived dangers that emissions might reveal a unit's location.[64]

In the previously mentioned Gulf War friendly fire incident, an AH-64 Apache battalion commander, due to inadequate combat identification, mistakenly engaged a Bradley Fighting Vehicle killing two and injuring four. This showed clearly that despite all of it's high-tech gadgetry, the Apache and it's human pilot cannot distinguish between friendly and enemy forces in adverse weather conditions obscuring visual identification and verification.[65] Without some sort of transponder or IFF device, U.S., allied and coalition ground combat vehicles could continue to be mistaken targets in future conflicts.

As previously documented, ground combat identification accounted for nearly all the incidents of fratricide in the Gulf War. Admittedly, however, combat identification is not a simple task. Rudolf Buser, Director of the U.S. Army Communications and Electronics Command's (CECOM) Night

Vision and Electro-Optics Directorate at Fort Belvoir,
Virginia, succinctly delineated the complexities of combat
identification.

> "Combat identification is a complex
> problem involving trade-offs in
> performance, covertness, cost and other
> factors, and no single solution exists.
> The Army is pursuing a number of
> technical approaches to solve the
> problem."[66]

The Desert Storm experience served as a 'wake-up' call
for those designing and developing future systems. In the
future, combat and materiel developers must fully consider
positive combat identification. The capability to
positively identify ground combat vehicles must be equal to
or greater than the engagement range. Technology must be
integrated and matched to minimize the occurrence of
fratricide.

OPERATION DESERT STORM QUICK FIXES

Following the first incidence of fratricide with
the Marines at the battle of Kafja, a number of emergency
efforts were made to prevent fratricide. These efforts
recognized the combat identification gap as it applied to
ground combat vehicles. With the full fledged ground war
impending, Department of Defense (DoD) initiated a number of
Quick Fixes during the Gulf War. One of the devices was an
infrared beacon, termed an Anti-Fratricide Identification
Device (AFID). Procured in only 24 days by the Defense
Advanced Research Projects Agency (DARPA), the infrared

beacon used two high-powered infrared diodes to emit optical power. Because of air supremacy, there was little danger that Iraqi aircraft could use emissions from the devices to target coalition vehicles. The AFID employed a protective collar to prevent infrared energy from being seen by ground forces. Used in conjunction with Night Vision Goggle (NVG) technology, the devices allowed coalition pilots to detect and identify the AFID emissions from as far away as 8-10 kilometers. Between inception and full scale production, engineers made over 100 mechanical, electrical and functional design changes in just four days. Though initially called AFID, it became known as the DARPA Light, after the agency which procured it. The DARPA Light had a 50 hour battery life. Each device shipped to the desert had two additional battery packs.[67]

Another infrared emitting device, designed by Army night vision engineer Henry 'Bud' Croley, did not have a shroud to preclude ground detection. This allowed Bradley and Abrams crews to see them, as opposed to limiting detection to fixed or rotary wing aircraft. The device was dubbed the 'Budd Light', partially in deference to Croley, and most certainly as a reminder of the customs of the host nation.

The Army rushed over 120,000 square feet of thermal tape to the theater. This tape was used to 'mark' vehicles as friendly when acquired by heat seeking target acquisition sights. Because the coalition forces had no monopoly on

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infrared and night-vision sensors, there was concern that the thermal panels might serve as bull's-eyes for Iraqi forces. In Desert Storm that did not happen.

The Army also ordered over 10,000 Small Lightweight Global Positioning Receivers to assist vehicles in determining their location. Although only effective in daylight and with good visibility, the coalition forces also used a field expedient side marking technique. VS-17 panels marked ground vehicles on the top and inverted 'V's marked side panels on coalition vehicles, identifying them as friendly forces. Inverted "V" symbols consisted of a variety of materials. The materials ranged from fluorescent placards, white luminous paint, black paint and thermal tape. Overall, these measures proved to be marginally effective.

INITIATIVES TOWARDS RESOLUTION

The immediate and overwhelming positive efforts in fielding 'expedient' remedies during the Gulf War were admirable. However, these efforts did not work well and failed to negate the impacts of bad weather, poor visibility and night combat conditions. Retired Navy Commander George Cornelius summarized the impact in a U.S. Naval Institute Proceedings article.

> "Cheap, simple measures to identify friendly armor have not worked well. Colored panels are invisible at night and at best seen only at close range; colored lights were better, but easily duplicated by the enemy."[68]

Because of the minimal positive impacts of 'Quick Fixes', efforts to return to the pursuit of Identification Friend or Foe (IFF) technology redoubled. Following the war, the Department of Defense established a Joint Combat Identification Management Office. The office coordinates the activities of the services. The U.S. Navy is the lead service in the area of cooperative airborne identification. The Navy's focus is on upgrading existing IFF systems for air-to-air and surface-to-air contacts. Under the auspices of The Program Executive Officer for Intelligence and Electronic Warfare, the U.S. Army Battlefield Combat Identification Systems leads the largest effort, that of ground combat identification. It is a Project Management Office (Colonel, Project Manager). The U.S. Army Materiel Command and the Deputy Chief of Staff for Research, Development and Acquisition provide materiel and hardware solutions. The U.S. Army Training and Doctrine Command is responsible for testing and evaluation.[69]

The Army began installation of immediately available off-the-shelf navigational applications on the M1A1 tank, the M2/M3 Bradley Fighting Vehicles, and the "Hummer" utility vehicle. These applications are an interim solution, pending investigation of alternative technologies. The devices add additional position/navigation (POS/NAV) and situational awareness capabilities. The receivers to be installed are the Small Lightweight Global Receiver (SLGR) and the Precision Lightweight Global Receiver (PLGR).[70]

The Combat Identification Project Management Office currently focuses on a 'near-term' solution to the problem. Following tests at a 'fly-off competition' conducted at Fort Bliss, Texas in 1992, the Army selected millimeter wave (MMW) technology for further development. Competing against infrared laser beacons, retro-reflector lasers, and radio-frequency (RF) based solutions, DoD selected MMW technology for further development because it is least affected by smoke or bad weather.[71]

The Project Office faces many challenges, the least of which is cost. The estimated cost for equipping a single division's worth of vehicles is currently estimated to be $250 million.[72] The Assistant Secretary of Defense for Command, Control, Communications and Intelligence, based on an assessment by the Joint Requirements Oversight Council (JROC), recommends near-term armor identification techniques on the order of $1,000 per application.[73] Additionally, the Project Office must ensure that MMW technology is compatible with US Navy and Air Force combat identification plans.[74]

A less expensive alternative to spending $250 million per division is to equip approximately 1,500 vehicles. This would be sufficient to support a substantial contingency force. The Office of Technology Assessment estimates an outlay of about $100 million to outfit such a force with MMW technology.[75]

Many positive initiatives grew from the Desert Storm experience with fratricide. In April 1993, the Army Deputy

Chief of Staff for Operations and Plans published the Operational Requirements Document (ORD) for the Battlefield Combat Identification System (BCIS).[76] The document mandated the need for a target identification system with ground-to-ground and air-to-ground capability. This ORD supported the April 1992 U.S. Army and Doctrine Command Operational and Organizational (O&O) Plan for Army Combat Identification Systems which required an effective and survivable combat identification system to preclude engagement of friendly forces and noncombatants. The O&O plan mandated the capability to positively engage targets out to the maximum effective range of the designated weapons system, with or without line of sight (LOS) technologies.[77]

The U.S. Army Training and Doctrine Command published TRADOC Pamphlet 525-58, U.S. Army Operations Concept for Combat Identification, in August 1993. The pamphlet provides the Army with a concept for combat identification which will increase combat effectiveness, prevent fratricide, and protect neutrals and noncombatants.

In December of 1993, the Vice Chairman of the Joint Chiefs of Staff directed that the Joint Requirements Oversight Council (JROC) screen all future Operational Requirements Documents (ORD) to ensure that no new combat systems proceed to a Milestone I decision unless combat identification is specifically addressed.[78] Additionally, Department of Defense Directive 5000.2 will be modified to

require evaluation of weapon systems combat identification capabilities at all milestone reviews.

CONCLUSIONS AND RECOMMENDATIONS

Operation Desert Storm confirmed a gap in the application of technology to positively identify ground combat vehicles. The incidence of fratricide, unprecedented in Twentieth Century war, confirmed the need for combat and materiel developers to carefully analyze the application of technology into our major weapons systems. Although we could acquire targets at previously unfathomable ranges, we could not always confirm positive combat identification. The identification of 'blind' spots highlighted our inability to positively identify ground combat vehicles.

Implementation of Quick Fixes during the Gulf War was a start in resolving the combat identification problem. Current initiatives in millimeter wave technology are similarly positive. In conjunction with these initiatives the Department of Defense and the Department of the Army should pursue the following actions to further reduce the incidence of fratricide in future conflicts.

o   Continue to emphasize the importance of combat training and rehearsals with particular attention placed on fratricide prevention.

o   Continue the development and distribution of training materials such as the U.S. Armor School's Fratricide videocassette.

o   Continue to develop joint doctrine and train to it with more Joint Training Exercises.

o   Include fratricide prevention in all Mission Needs Statements and associated operational requirement documents for our combat systems.

o   Continue emphasis on fratricide at all Training Centers (National Training Center and the Joint Readiness Training Center).

o   Require combat and materiel developers to conduct a thorough risk assessment for all systems, including fratricide prevention capabilities.

o   Enforce the requirement that combat identification capability be equal to engagement ranges of particular weapon systems.

o   Continue to pursue all service integration of IFF technology, with specific emphasis on combat ground vehicles.

o   Closely monitor and enforce consideration of combat identification capabilities at all Milestone reviews.

While the success of the Gulf War cannot be negated, the lessons learned from the high incidence of fratricide must serve as a reminder that requirements must drive technology, not vice versa. In the future, combat and materiel developers must anticipate and compensate for the consequences of partial or non-integrated application of technology. The ultimate solution must address multiple areas to include doctrine and procedures, organization,

training, the application of advanced technologies and hardware. Fratricide prevention must be a standing requirement for all combat and material developments.' We owe our nation's armed forces nothing less.

ENDNOTES

[1] Michael R. Gordon, "U.S. Jets Over Iraq Attack Own Helicopters in Error;   All 26 on Board Are Killed.", The New York Times 15 April 1994, sec. A: 1.

[2] Harry Summers, "War's unchanging truths can be ignored at our peril", Army Times 2 January 1995: 70.

[3] John F. Harris, "Building Force XXI: The Army's Special Task Force on Digitization," The Washington Post 24 April 1994, sec. A: 18.

[4] U.S. Department of the Army, Fratricide: Reducing Self-Inflicted Losses, Newsletter No. 92-4 Fort Leavenworth, KS: Center for Army Lessons Learned, U.S. Army Combined Arms Command, April 1992, 3.

[5] Kenneth K. Steinweg, Piercing the Fog of War Surrounding Fratricide: The Synergy of History, Technology, and Behavioral Research, U.S. Army War College,   (Carlisle Barracks, PA: U. S. Army War College, 1994) 42.

[6] Charles R. Shrader, Amicicide: The Problem of Friendly Fire in Modern War, U.S. Army Command and General Staff College, (Fort Leavenworth, KS: Combat Studies Institute, 1982) 146.

[7] The Papers of George Washington, Colonial Series, vol. 6, W.W. Abbot, ed. (Charlottesville, VA: University Press of Virginia, 1988), pp. 120-123.

[8] Charles F. Hawkins, "Friendly Fire: Facts, Myths and Misperceptions.", U.S. Naval Institute Proceedings 120/6/1,096 (June 1994): 56.

[9] John G. Roos, "Army Enters Round Two of Four-round Anti-Fratricide Fight.", Armed Forces Journal November 1993, 10.

[10] Hawkins, 56.

[11] Thomas W. Lippman, "Instances of Friendly Fire Are Not Surprising on the Battlefield.", The Washington Post 3 February 1991, sec. A: 23.

[12] Shrader, 21.

[13] Emmett Paige Jr, "Fratricidal Friendly Fire Must End.", Defense Issues, Vol. 9, No. 68 (2 August 1994): 1.

[14] U.S. Department of Defense, "19 June 90 Regular Briefing (Pete Williams)."

[15] Vito DeMonte, "Avoiding Fratricide: Is the Endgame Solution the Answer?", Journal of Electronic Defense 15 (July 1992): 34-36.

[16] Robert MacKay, "Army Hopes ID Device for Vehicles Will Cut Friendly Fire Deaths," The Washington Post 8 March 1993, sec. A: 4.

[17] U.S. Congress. Office of Technology Assessment, Who goes there: Friend or Foe?, 103d Cong., OTA-ISC-537 Washington, D.C.: GPO, June 1993, Foreword, iii.

[18] Gary W. Wright, Scatterable Munitions = Unexploded Ordnance = Fratricide., U.S. Army War College, (Carlisle Barracks, PA: U. S. Army War College, 1993) 46.

[19] Rick Atkinson, "Fratricide Problem Defies Decades of Efforts," The Washington Post 15 April 1994, sec. A: 19.

[20] (U.S. Congress, Office of Technology Assessment, June 1993, 1)

[21] Shrader, vii.

[22] Charles R. Shrader, "Friendly Fire: The Inevitable Price," Parameters 22 (Autumn 1992): 31.

[23] MacKay, sec. A: 4.

[24] Steinweg, 1.

[25] Steinweg, 29.

[26] David M. Sa'adah, "Friendly Fire: Will We Get It Right This Time?" Paper presented to the 31st U.S. Army Operations Research Symposium, Fort Lee, Virginia, November 1992.

[27] John D. Morrocco, "Gulf War Boosts Prospects For High-Technology Weapons," Aviation Week & Space Technology 18 March 1991: 45.

[28] (U.S. Congress, Office of Technology Assessment, June 1993, 27)

[29] David M. Sa'adah, "Fratricide: Attitudes, Magnitude, and Change." A Report to the 1994 Combat Identification System Conference.

[30] Zachary A. Lum, "My Brother's Keeper: Technology Tackles Fratricide Prevention," Journal of Electronic Defense 16 (August 1993): 49.

[31] Sa'adah, 8.

[32] Lum, 48.

[33] George Cornelius, "U.S. Forces Seek Affordable Solutions To Combat Identification Problems," Signal 49 (September 1994): 72.

[34] Paige, 2.

[35] (U.S. Department of the Army, April 1992, 9)

[36] Barton Gellman and John Lancaster, "Breakthrough to Avert 'Friendly Fire' in War is Years Away, Army Says," The Washington Post 13 December 1991, sec. A: 10.

[37] (U.S. Congress, Office of Technology Assessment, 2)

[38] George Cornelius, "Halt! Bang! Who Goes There?" U.S. Naval Institute Proceedings 119/6/1,084 (June 1993): 89.

[39] Paige, 3.

[40] DeMonte, 35.

[41] U.S. Department of the Army, Fratricide, 4.

[42] Barton Gellman, Ralph Gaillard Jr. and Lucy Shackleford, "Gulf War's Friendly Fire Tally Triples," The Washington Post 14 August 1991, sec. A: 1.

[43] Abigail Trafford, "Fallout from 'Friendly Fire,'" The Washington Post 12 February 1991, sec. WH: 6.

[44] Bill Hewitt and Kent Demaret, "Honor, Duty, Disgrace," People Weekly 4 June 1992: 92.

[45] Barton Gellman, "'Oh My God' - Then He Was Gone," The Washington Post 20 October 1991, sec. A: 1.

[46] Ibid.

[47] Arthur Hadley, "Coming to Terms with 'Friendly Fire,'" The New York Times 24 February 1994, sec. A: 19.

[48] Barton Gellman, "'Oh My God'-Then He Was Gone," The Washington Post 20 October 1991, sec. A: 19.

[49] Cal Fussman, "Casualties of War," Life August 1992: 70.

[50] Hadley, A19.

[51] David H. Hackworth, "Killed by Their Comrades," Newsweek 18 November 1991: 46.

[52] Hawkins, 58.

[53] Headquarters, Department of the Army, United States Combat Developments Command, Fort Belvoir, VA 22060, Subject: United States Casualties from Own Fires (U), 6 November 1967.

[54] U.S. Department of the Army, Infantry Fighting Vehicle/Cavalry Fighting Vehicle (IFV/CFV) Cost and Operational Effectiveness Analysis (COEA), U.S. Army Training and Doctrine Command, 15 October 1978.

[55] Headquarters, Department of the Army, United States Army Combat Developments Command, Combat Vehicles - 1975, 15 November 1963. and Headquarters, Department of the Army, United States Army Combat Developments Command, Tank, Antitank and Assault Weapons Requirements Study (U), 1 May 1967.

[56] Headquarters, Department of the Army, Office of the Assistant Secretary, Subject: Battlefield IFF for Tank Identification, 15 February 1974.

[57] Headquarters, Department of the Army, Office of the Assistant Secretary, Subject: Identification Friend-or-Foe of Ground Combat Vehicles, 2 June 1982.

[58] Science Applications, Inc., Non-Cooperative Battlefield Identification Friend, Foe, or Neutral: An Analysis and Conceptual Design (U), April 1979.

[59] Wright, 17.

[60] Ibid.

[61] U.S. General Accounting Office, OPERATION DESERT STORM: Casualties Caused By Improper Handling of Unexploded U.S. Submunitions, Washington, D.C.: GAO, August 1993, 7.

[62] Ibid., 8.

[63] Patrick E. Tyler, "Pentagon Rethinking Techniques To Prevent Attacks on Own Tanks," The New York Times 15 August 1991, sec. A: 10.

[64] Cornelius, 89.

[65] Robert Johnson and Caleb Solomon, "Chilling Tapes Show How Soldiers Died in 'Friendly Fire,'" The Wall Street Journal 7 November 1991, sec. A: 1.

[66] John T. Morzenti, "Letter Insults Makers of Night-Vision Gear," The Wall Street Journal 27 November 1991, sec. A: 9.

[67] David Hughes, "Small Firm Acted Quickly to Design, Field Infrared Beacons for Vehicles," Aviation Week & Space Technology 20 May 1991: 54-56.

[68] Cornelius, 90.

[69] Barbara Starr, "US advances on battlefield ID," International Defense Review 26 (December 1993): 961.

[70] Ibid.

[71] Ibid.

[72] Ibid.

[73] Paige, 3.

[74] Starr, 961.

[75] Roos, 9.

[76] Headquarters, Department of the Army, Office of the Deputy Chief of Staff for Operations and Plans, Subject: Proposed Operational Requirements Document (ORD) for the Battlefield Combat Identification System (BCIS), 14 April 1993.

[77] Department of the Army, Headquarters, United States Army Training and Doctrine Command, Subject: Revised Operational and Organizational (O&O) Plan for Army Combat Identification System (ACIS), 28 April 1992.

[78] The Joint Staff, Subject: Combat Identification (CID), 9 December 1993.

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BIBLIOGRAPHY

Apple, R. W., Jr.   "Military Errors: The Snafu as History."
The New York Times, 5 July 1988,   sec A, p. 8.

_____. "Trigger Fingers." _The New York Times_, 15 April
1994, sec. A, p. 1.

Arnold, Wallace C.   "MANPRINT and the Digitized
Battlefield." _Army RD&A_ (November-December 1994):   39-
41.

Arnold, Wallace C., and Dr. Thomas H. Killion.   "The
Soldier-Information Interface." _Army RD&A_ (January-
February 1995):   7-10.

Atkinson, Rick.   "Fratricide Problem Defies Decades of
Efforts." _The Washington Post_, 15 April 1994, sec A,
p. 19.

Auster, Bruce B.   "The perils of peacekeeping." _U.S News
and World Report_, 25 April 1994, 28.

Bond, David F.   "Army Speeds Helicopter Enhancements In
Response to Desert Storm Problems." _Aviation Week &
Space Technology_, 1 April 1991, 25.

Bryan, C.D.B.   _Friendly Fire_. New York: G.P. Putnam's Sons,
1976.

Burn, Marion L., III, Martin Goldsmith and James Hodges.
_Applying the National Training Center Experience:
Artillery Targeting Accuracy_, The RAND Corporation,
N2984-A, April 1990.

Campen Alan D., ed.   _The First Information War_. Fairfax,
VA: AFCEA International Press, 1992.

Conway, Thomas G.   "America's Army...Into the 21st Century."
Army RD&A (January-February 1995):   11-13.

Cornelius, George.   "Halt! Bang! Who Goes There?" _U.S.
Naval Institute Proceedings_ 119/6/1,084 (June 1993):
89-91.
_____. "IFF Update." _U.S. Naval Institute Proceedings_
119/6/1,084 (June 1993):   91.

_____. "IFF Update: Stalled Again." _U.S. Naval
Institute Proceedings_ 120/6/1,096 (June 1994):   58-59.

_____."U.S. Forces Seek Affordable Solutions To Combat
Identification Problems." _Signal_ 49 (September 1994):
71-74.

Coyne, Mark. "CECOM Works to Eliminate 'Not So Friendly'
     Fire." Army RDA (September-October 1992): 34-35.

Deeb, Gregory P. "Accurate All-Weather Close Air Support."
     Marine Corps Gazette 78 (May 1994): 58-59.

Demaret, Kent., and Bill Hewitt. "Honor, Duty, Disgrace."
     People Weekly, 6 April 1992, 89-92.

DeMonte, Vito. "Avoiding Fratricide." Journal of
     Electronic Defense 15 (July 1992): 34-36.

Dickerson-Kindred, Janice. "RD&E Centers Play Key Role in
     Force XXI." Army RD&A (January-February 1995): 19-21.

Dickson, Dwight B. Jr., and Elrin L. Hundley. "Avoiding Not
     So Friendly Fire." Military Review 72 (July 1992):57-
     64.

Distler, Bill. "Friendly fire: war and naivete."
     Christianity and Crisis, 8 April 1991, 100.

Dubik, James M., and Gordon R. Sullivan. War in the
     Information Age. Carlisle, PA: Strategic Studies
     Institute, June 1994.

Fitzsimonds, James R., and Jan M. Van Tol. "Revolutions in
     Military Affairs." Joint Force Quarterly 4 (Spring
     1994): 24-31.

Forster, William H. "'The Toughest Challenge We Face'."
     Army 45 (February 1995): 31-34.

Frankel, Michael S. "The 1994 Army Science board
     Recommended Technical Architecture for the Digital
     Battlefield." Army RD&A (November-December 1994):
     7-11.

Franks, Frederick M., Jr. "Winning the Information War."
     Vital Speeches of the Day 60 (15 May 1994): 453-458.

Fussman, Cal. "Casualties of War." Life (August 1992):
     63-70.

Gellman, Barton. "'Oh My God'-Then He Was Gone." The
     Washington Post, 20 October 1991, sec. A, p. 1.

Gellman, Barton., and John Lancaster. "Breakthrough to
     Avert 'Friendly Fire' in War Is Years Away, Army Says."
     The Washington Post, 13 December 1991, sec. A, p. 10.

Gellman, Barton. "Gulf War's Friendly Fire Tally Triples."
     The Washington Post, 14 August 1991, sec. A, p. 1.

Giordano, Robert F., and Otto Guenther. "Enabling Technologies and Advanced Concepts for the Digitized Force XXI." Army RD&A (November-December 1994): 21-24.

Goldsmith, Martin. Applying the National Training Center Experience-Incidence of Ground-to-Ground Fratricide, The RAND Corporation, N-2984-A, April 1990.

Gordon, Michael R. "U.S. Jets Over Iraq Attack Own Helicopters in Error; All 26 Aboard Are Killed." The New York Times, 15 April 1994, sec A, p. 1.

Grady, John E. "Army Physicians Make Electronic House Calls." Army 45 (February 1995): 39-40.

_____. "Building Force XXI: The Army's Special Task Force on Digitization." Army 44 (March 1994): 19.

Greenwood, John E. "Editorial: Fratricide: The Underlying Causes." Marine Corps Gazette 78 (May 1994): 2.

Griffin, Gary B. "Future Foes, Future Fights." Military Review 75 (November 1994): 56-60.

Guilmartin, John F., Jr. "Technology and Strategy: What are the Limits?" Two Historians in Technology and War Carlisle: Strategic Studies Institute, 1994.

Hackworth, David H. "Killed by Their Comrades." Newsweek, 18 November 1991, 45.

_____. "Lessons of a Lucky War." Newsweek, 11 March 1991, 49.

Hadley, Arthur. "Coming to Terms with 'Friendly Fire'." The New York Times, 24 February 1994, sec. A, p.19.

Hammer, Joshua., and Douglas Waller. "Risking 'Friendly Fire'." Newsweek, 4 March 1991, 33.

Harris, John F. "Downing of Copters Blamed on Blunders." The Washington Post, 14 July 1994, sec. A, p. 1

_____. "In Electronic Battlefield Training Exercise, "Fog of War' Remains Thick." The Washington Post, 24 April 1994, sec. A, p. 18.

Hawkins, Charles F. "Friendly Fire: Facts, Myths and Misperceptions." U.S. Naval Institute Proceedings 120/6/1,096 (June 1994): 54-59.

Hillman, James L. Task Force 1-41 Infantry: Fratricide

Experience in Southwest Asia, Carlisle Barracks, PA:
    U.S. Army War College, 1993.

Hollands, David D. "Preventing Fratricide in the LID."
    Field Artillery (June 1993): 44-45.

Hughes, David. "Defense Dept. Must Exploit Commercial
    Technology." Aviation Week & Space Technology, 24
    December 1990, 23.

_____. "Small Firm Acted Quickly to Design, Field
    Infrared Beacons for Vehicles." Aviation Week & Space
    Technology, 20 May 1991, 54.

Iarte, Gerald., and David Seitz. "Research Efforts for
    Force XXI." Army RD&A (January-February 1995): 14-15.

Johnson, Robert., and Caleb Solomon. "Chilling Tapes Show
    How Soldiers Died in 'Friendly Fire'." The Wall Street
    Journal, 7 November 1991, sec. A, p. 1.

Kalil, Robert J. "We're Not Doing Enough About Friendly
    Fire." U.S. Naval Institute Proceedings 12/6/1,096
    (June 1994): 60.

Lacayo, Richard. "Deadly Mistaken Identity." Time, 25
    April 1994, 50.

Lippman, Thomas W. "Instances of 'Friendly Fire' Are Not
    Surprising on the Battlefield." The Washington Post,
    3 February 1991, sec A, p. 23.

Lum, Zachary A. "Army Will Choose A Near-Term CID [Combat
    Identification] Solution." Journal of Electronic
    Defense 15 (July 1992): 35.

_____. "My Brother's Keeper: Technology Tackles
    Fratricide Prevention." Journal of Electronic Defense
    16 (August 1993): 48-51.

_____. "Technology Brightens Night Fighting
    Possibilities." Journal of Electronic Defense 15
    (November 1992): 37-41.

MacKay, Robert. "Army Hopes ID Device for Vehicles Will Cut
    Friendly Fire Deaths." The Washington Post, 8 March
    1993, sec. A, p. 4.

McGinnis, Michael L. , and George F. Stone III. "Decision
    Support Technology." Military Review 74 (November
    1994): 68-75.

Morrocco, John D. "Fratricide Investigation Spurs U.S.
    Training Review." Aviation Week & Space Technology,

18 July 1994, 23.

_____. "Gulf War Boosts Prospects For High-Technology
    Weapons." Aviation Week & Space Technology, 18 March
    1991, 45.

O'Connor, Michael P. Fratricide: A Preventable
    Technological Disease. Carlisle Barracks, PA: U.S.
    Army War College, 1992.

Ohle, David H. "The Campaign Plan." Army 45 (February
    1995): 19-20.

Paige, Emmett, Jr. "Fratricidal Friendly Fire Must End."
    Defense Issues, Vol. 9, No. 68, 2 August 1994.

Predham, James R. "Army Research Laboratory Contribution to
    Force XXI." Army RD&A (January-February 1995): 16-18.

Reitinger, Kurt C. "Command and Control for Third Wave
    Warfare." Army 45 (February 1995): 9-14.

Rigby, Joe W. "Acquiring the Digitized Force." Army RD&A
    (November-December 1994): 16-17.

Roos, John G. "Army Enters Round Two Of Four-Round Anti-
    Fratricide Fight." Armed Forces Journal International
    (November 1993): 9-10.

_____. "Training and Simulation: Battleground For
    Digitized Warriors." Armed Forces Journal
    International (November 1993): 40-41.

Ryan, Donald E., Jr. "Implications of Information-Based
    Warfare." Joint Force Quarterly 6 (Autumn/Winter 1994-
    95): 114-116.

Sa'adah, David M. "Fratricide: Attitudes, Magnitude, and
    Change." A Report to the 1994 Combat Identification
    Systems Conference.

_____. "Friendly Fire: Will We Get It Right This
    Time?" November 1992. Paper presented to the 31st
    U.S. Army Operations Research Symposium, Fort Lee, VA.

Salomon, Leon E. "Providing the Technological Edge." Army
    45 (February 1995): 25-28.

Schmitt, Eric. "Copter Deaths: Pentagon Finds Human
    Failure." The New York Times, 1 July 1994, sec. A, p.
    1.

_____. "U.S. Acts to Bar Repeat of Helicopter Loss."
    The New York Times, 14 July 1994, sec. A, p. 6.

_____. "U.S. Striving to Prevent 'Friendly Fire'." The New York Times, 9 December 1991, sec. A, p. 12.

Schrader, Charles R. Amicicide: The Problem of Friendly Fire in Modern War, Fort Leavenworth, KS: Combat Studies Institute, U.S. Army Command and General Staff College, December 1982.

_____. "Friendly Fire: The Inevitable Price." Parameters 22 (Autumn 1992): 29-44.

Smith, Bruce A. "Army to Award Development Contract For Improved TOW Missile Infrared Sight." Aviation Week & Space Technology, 10 June 1991, 60.

Starr, Barbara. "US advances on battlefield ID." International Defense Review 26 (December 1993): 961.

Steinweg, Kenneth K. "Dealing Realistically With Fratricide." Parameters 25 (Spring 1995):   4-29.

_____. Piercing the Fog of War Surrounding Fratricide: The Synergy of History, Technology, and Behavioral Research, Carlisle Barracks, PA: U.S. Army War College, 1994.

Stewart, Robert L. "New Technology: Another Way to Get Oats to the Horses?" Army 45(January 1995): 22-27.

Sullivan, Gordon R. "Force XXI: Digitizing the Battlefield." Army RD&A (November-December 1994): 2-3.

Summers, Harry. "War's unchanging truths can be ignored at our peril." Army Times, 2 January 1995, 70.

Szafranski, Richard. "Neocortical Warfare? The Acme of Skill." Military Review 74 (November 1994): 41-55.

Towell, Pat. "Bill Questions High-Tech Rush, Urges Careful Weapons Tests." Congressional Quarterly Weekly Report, 18 May 1991, 1292.

Trafford, Abigail. "Fallout From 'Friendly Fire'." The Washington Post, 12 February 1991, sec WH, p. 6.

Tyler, Patrick E. "Pentagon Rethinking Techniques To Prevent Attacks on Own Tanks." The New York Times, 15 August 1991, sec A, p.10.

U.S. Congress. Office of Technology Assessment, _Who goes there: Friend or Foe?_, 103d Cong., OTA-ISC-537 Washington, D.C.: GPO, June 1993.

U.S. Department of the Army, _Force XXI Operations_. TRADOC Pam 525-5. Fort Monroe, VA: Training and Doctrine Command, 1 August 1994.

_____. _Fratricide_, produced and directed by U.S. Army Armor School, Fort Knox, KY, color, 65 min, 1992. Videocassette.

_____. _Fratricide: Reducing Self-Inflicted Losses_. Newsletter No. 92-4. Fort Leavenworth, KS: Center for Army Lessons Learned, U.S. Army Combined Arms Command, April 1992.

_____. _Fratricide Risk Assessment for Company Leadership_, Handbook No. 92-3. Fort Leavenworth, KS: Center for Army Lessons Learned, U.S. Army Combined Arms Command, March 1992.

U.S. Department of Defense. "19 June 1990 Regular Briefing (Pete Williams)."

U.S. General Accounting Office. _Minimizing Friendly Fire_. Washington, D.C.: United States General Accounting Office. October 1993.

_____. _OPERATION DESERT STORM: Apache Helicopter Fratricide Incident_. Washington, D.C.: United States General Accounting Office. June 1993.

_____. _OPERATION DESERT STORM: Casualties Caused By Improper Handling of Unexploded U.S. Submunitions_. Washington, D.C.: United States General Accounting Office. August 1993.

van Voorst, Bruce. "They Didn't Have to Die." _Time_, 26 August 1991, 20.

Vogel, Steve. "We Have Met the Enemy. And It Was Us." _The Washington Post_, 9 February 1992, sec. F, p. 1.

Weiser, Benjamin. "Tackling Problems from 'Friendly Fire' to Sandbags." _The Washington Post_, 17 February 1991, sec. A, p.1.

Wright, Gary W. _Scatterable Munitions = Unexploded Ordnance (UXO) = Fratricide_, Carlisle Barracks, PA: U.S. Army War College, 1993.